NORTHERN TIER
St. Paul Park Refining

December 14, 2015

CERTIFIED MAIL:
9171 9690 0935 0093 2475 63

AQ Compliance Tracking Coordinator
Industrial Division
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

CERTIFIED MAIL:
9171 9690 0935 0093 2475 70

USEPA Region V
Director, Air and Radiation Branch
77 West Jackson Boulevard
Chicago, IL 60604-3507

RE: Hydrogen Cyanide Test Report
Request to Fulfill the One-Time HCN Performance Test Requirement
EU 004/ SV 003 - EQUI 2 FCC Regenerator
St. Paul Park Refining Co. LLC
Title V Permit (#16300003-021)

Dear Sir/Madam:

Enclosed is the May 27, 2015 Hydrogen Cyanide (HCN) screening test report for the FCCU located at the St. Paul Park Refining Co. LLC (SPPRC). In accordance with 40 CFR 63.1571 which indicates that if you conducted a performance test for HCN for a specific catalytic cracking unit between March 31, 2011 and February 1, 2016, you may request to the Administrator to use the previously conducted performance test results to fulfill the one-time performance test requirement results to fulfill the one-time performance test requirement for HCN. SPPRC herein submits a request to use its May 27, 2015 HCN test to fulfill the one time test requirement for the catalytic cracking unit located at the St. Paul Park facility.

The testing was completed May 27, 2015 for screening HCN concentration data in the FCC. The report was completed December 11, 2015. The HCN results were 0.402 lb/10^3 lb coke burn, which is consistent with the emission factor published April 2015 in EPA AP-42 Table 5.1-2 which had a result of 0.43 lb/10^3 lb coke burn. As the test result is consistent with the EPA emission factor, SPPRC plans to use the EPA factor for potential to emit calculations if this HCN test is used to meet the one time performance test requirement in 40 CFR 63.1571. Also in accordance with 40 CFR 63.1571 if the Administrator does not respond to the facility within 60 days of receipt of the request, SPPRC will consider the May 27, 2015 HCN test meets the one time test requirement.

Please contact me at (651) 769-6769 if you have any questions.

Sincerely,

Kirby Dahlquist

Kirby Dahlquist
Environmental Professional
St. Paul Park Refining Co. LLC

Enclosure

Pace Analytical
Field Services Division

Pace Analytical Services, Inc.
1700 Elm Street SE
Minneapolis, MN 55414
Phone: 612.607.1700
Fax: 612.607.6388
www.pacelabs.com

Emissions Test Report

St. Paul Park Refining Co. LLC
Hydrogen Cyanide
Screening

Testing Date(s): May 27, 2015
Report Date: December 11, 2015
Revision Date: No revision to date

Subject Facility:

St. Paul Park Refining Co. LLC
301 St. Paul Park Road
St. Paul Park, MN 55071

Regulatory Permit No.:
16300003-020
AQ File No. 203A

Subject Emission Sources:

FCC Regenerator	EU004

Test Locations:

Stack	SV003

Report Prepared For:

Kirby Dahlquist
St. Paul Park Refining Co. LLC
301 St. Paul Park Road
St. Paul Park, MN 55071

Telephone No.: (651) 769-6769

Report Preparation Supervised By:

Terry Borgerding
Pace Analytical Services, Inc.
1700 Elm Street, Suite 200
Minneapolis, MN 55414
Telephone No.: (612) 607-6374
E-mail Address: terry.borgerding@pacelabs.com

Pace Project No. 12-15-1426

Table of Contents

Executive Summary

St. Paul Park Refining Co. LLC (SPPRC) contracted Pace Analytical Services, Inc. to perform hydrogen cyanide emissions screening on the FCC Regenerator at SPPRC located in St. Paul Park, Minnesota. Testing was performed on May 27, 2015. Summary results are highlighted in the following table:

Test Results Summary

Parameter	Run 1	Run 2	Average	AP-42[1]
Hydrogen Cyanide				
LB/HR	5.28	5.53	5.41	
LB/10^3 BBL Feed[2]	5.03	5.26	5.14	7.0
LB/10^3 LB Coke Burn[3]	0.392	0.412	0.402	0.43

[1] AP-42 April 2015 Table 5.1-2 listed emission factors.
[2] LB/10^3 BBL Feed = pounds of HCN per 1,000 barrels of feed.
[3] LB/10^3 LB Coke Burn = pounds of HCN per 1,000 pounds of coke burn.

Introduction

Pace Analytical Services, Inc. personnel conducted hydrogen cyanide (HCN) emission screening on the FCC Regenerator at SPPRC located in St. Paul Park, Minnesota. Brett Erickson performed on-site testing activities. Terry Borgerding provided administrative project management. Kirby Dahlquist with SPPRC coordinated plant activities during testing. On-site activities consisted of the following measurements:

- Hydrogen cyanide (HCN), two independent monitoring periods by gas-phase FTIR.

The project objectives were to approximate HCN emission constituents. These measurements were performed at greater than 50% of maximum operating conditions.

Subsequent sections summarize the test results and provide descriptions of the process and test methods. Supporting information and raw data are in the appendices.

Results Summary

Results of HCN screening are summarized in Table 1. The HCN emission rate averaged 5.41 LB/HR at 33.4 PPMv-Wet. A detailed log of results is located in Appendix B.

Testing was performed following a semi-quantitative quality protocol. The FTIR was purged with nitrogen and a clean background spectrum was collected. After purging, the FTIR was connected to a sample acquisition system already in use for another test and monitoring commenced. EPA Protocol carbon monoxide, nitric oxide, sulfur dioxide, and carbon dioxide calibration transfer standards were used as quantitation standards. Calibrations occurred between the two independent monitoring periods.

The data in this report are indicative of emission characteristics of the measured sources for process conditions at the time of the test. Representations to other sources and test conditions are beyond the scope of this report.

Summary Table

St. Paul Park Refining Co. LLC

St. Paul Park, MN
Pace Project No. 12-15-1426

Table 1

Speciated Constituent (M320) Results
FCC Regenerator Stack
Test 1

Parameter	Run 1	Run 2	Average
Date of Run	5/27/15	5/27/15	
Time of Run	1034-1208	1222-1251	
Sample Duration (Minutes)	95	30	
Process Operational Parameters			
Volumetric Flow Rate (DSCFM)	35,045	34,981	35,013
Feed Rate (BBL/Day)	25,221	25,264	25,243
Coke Burn (LB/HR)	13,482	13,426	13,454
Constituent Concentration, PPMv - Wet			
Hydrogen Cyanide	32.5	34.3	33.4
Constituent Mass Rate, LB/HR			
Hydrogen Cyanide	5.28	5.53	5.41
Constituent Mass Rate, LB/10^3 BBL			
Hydrogen Cyanide	5.03	5.26	5.14
Constituent Mass Rate, LB/10^3 LB Coke burn			
Hydrogen Cyanide	0.392	0.412	0.402

Process Description

The fluidized catalytic converter (FCC) unit converts gas oils from the refinery's crude distillation units into useful gasoline and liquid petroleum gas (LPG) products. Gas oil and several other streams mix in the FCC Charge Drum before the mixed stream is fed through the Charge Heater. Heated feed and fluidized catalyst mix and cracking reactions occur before the mixture of products and catalyst are separated at the FCC Reactor. The hydrocarbon mixture enters the FCC Main Column for additional separation, while separated catalyst falls to the Regenerator where the catalyst is regenerated by combustion of carbon on the catalyst.

Gases produced from combustion exit the Regenerator and enter a cyclone that removes catalyst fines from the flue gas. The air stream then enters the Multi-stage Separator, consisting of cyclones and bag filters to remove additional particulate matter from the flue gas. Flue gas exits the stack to the atmosphere.

The FCC is normally operated in complete combustion mode and was operated in this mode during the test. Combustion promoters used during the test were palladium.

Test Procedures

EPA Method 320 defines procedures to speciate and quantify gas-phase compounds using extractive Fourier Transform Infrared Spectrometry (FTIR). A probe and sample line of inert materials draw a sample gas stream from the source and continuously deliver it to a nickel-cadmium sample cell at a constant rate. Sample interface materials and application of heat depend on the constituents of interest. Method 320 - Appendix D presents calibration trials. Infrared energy directed through the cell and returned to an interferometer classifies spectral separations based on the sample gas composition. Collected mid-range infrared interferograms are converted to absorbance spectra then compared to existing library reference standards to identify and quantify gas constituents. A rotary vane pump downstream of the cell moves the gas sample through the interface components and safely to vent. Elevated interface temperatures inhibit condensation of moisture and volatile constituents when appropriate. In some instances, elevated concentrations of water and carbon dioxide can spectrally interfere with compound(s) of interest. Water and carbon dioxide spectra are specifically or empirically developed for a sample matrix. Standardized subtraction methods are applied to sample spectra to alleviate potential spectral interferences. Sample cell pressure is monitored and maintained within ± 10 in. WC of atmospheric. Details of FTIR instrumentation are shown below.

Sample Flow Rate:	~2 LPM
Probe Material:	Stainless Steel
Transfer Lines:	Teflon™
Sample Cells:	5.11 M
Cell Windows:	Zinc Selenide
Sample Interface Temp.:	~375°F
Instrument:	MKS MultiGas 2030 Gas Phase FTIR
Detector:	Mercury Cadmium Telluride (MCT)
Wave Number Range:	600 – 4500 cm^{-1}
Scans/Result:	16/128/256
Resolution:	0.5 cm^{-1}
Gain:	1

Pace FSD conducted this method with the following project situational deviations:

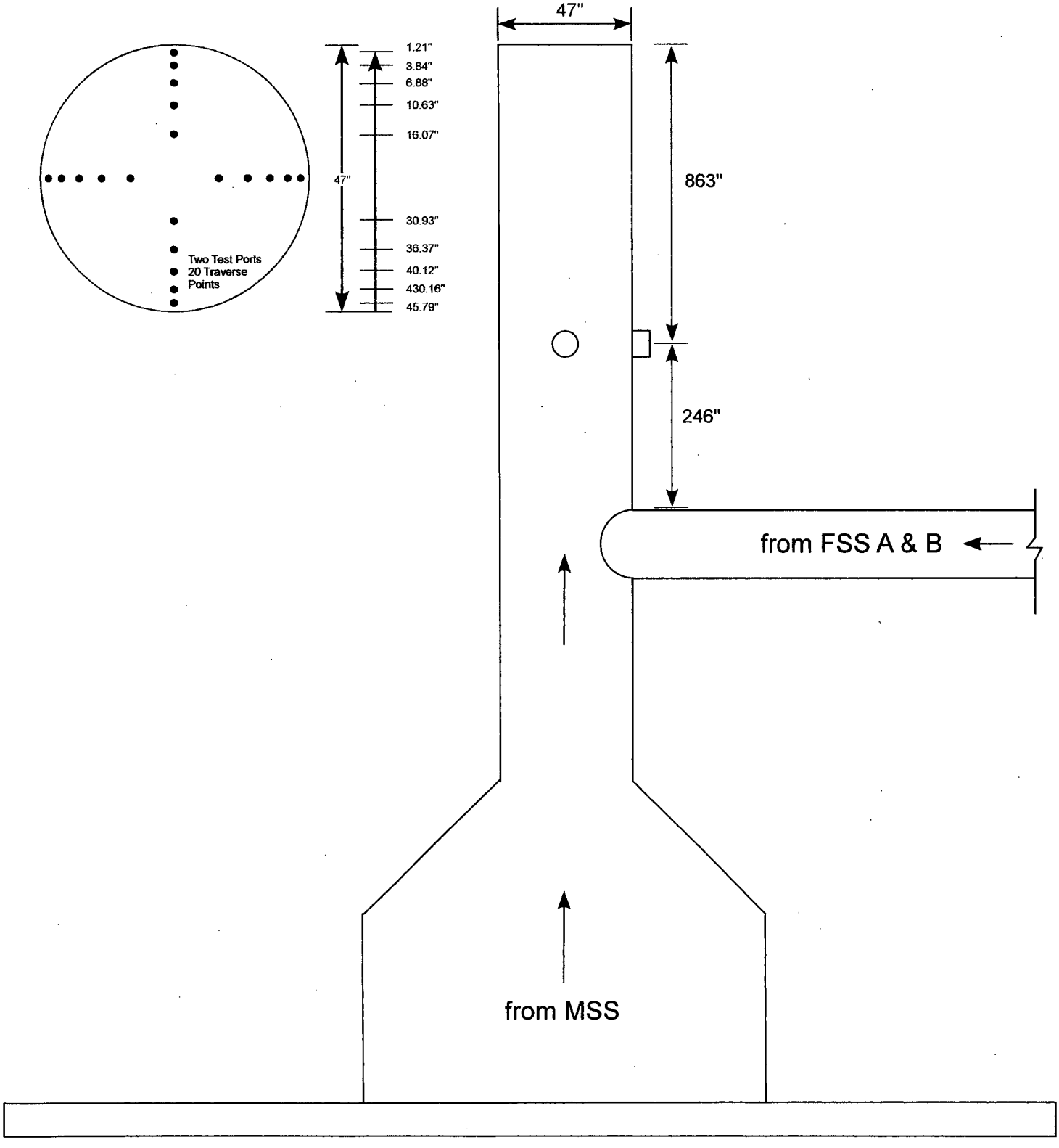
- Leak Checks performed per Method 3A (testing simultaneous)

Based on project data quality objectives, EPA Method 320 was modified to exclude:

- Matrix Spiking
- Fractional Calibration Uncertainties (FCU) calculations
- Fractional Method Uncertainties (FMU) calculations
- Root Mean Square Deviation (RMSD) calculations
- Bias of Spiking calculations

Pace Analytical
Field Services Division

Figure 1
St. Paul Park Refining Co. LLC
St. Paul Park, MN
FCC Stack (SV003)
DCL \ 2/14



Report Signatures

Field Testing and Reporting Performed by: Pace Analytical Services, Inc.
Field Services Division
1700 Elm Street, Suite 200
Minneapolis, MN 55414

Field Testing Affirmation

All field testing was performed in accordance with stated test methods subject to modifications and deviations listed herein. Raw field data presented in this report accurately reflects results and information as recorded at the time of tests or otherwise noted.

Report Affirmation

To the best of my knowledge, this report accurately represents the compiled field and laboratory information with no material omissions, alterations or misrepresentations.

Brett Erickson, QSTI
Field Analyst II

Date 12/4/15

Responsible Charge Affirmation

I have reviewed the information herein and it is approved for distribution.

Donald B. Stock, QEP, QSTI
General Manager, Field Services Division

Date 12/9/15

Appendix A

Source/Process/Plant Information

Emissions Monitoring Logs

Saint Paul Park Refining CO, LLC
St. Paul Park, MN
Hydrogen Cyanide (HCN) Testing FTIR
FCC Regenerator
EU 004, SV 003
Wednesday, May 27, 2015

Start Time	5/27/2015 10:34	5/27/2015 12:22
End Time	5/27/2015 12:08	5/27/2015 12:51

Description	Run 1	Run 2	Average	Permit Limit	Units
FCC TOTAL Feed CHARGE (BPD)	25,221	25,264	25,243	**NA**	BPD
FCC Regenerator Coke Burn	13,482	13,426	13,454	**NA**	lb/hr
FCC Regen Calcualted Flue Gas Flow	35,045	34,981	35,013	**NA**	SCFM, dry
FCC % OPACITY 6 MIN AVG	4.00	4.00	4.00	**<30%**	PCT
SO_2 LB/TON COKE BURN	2.06	2.02	2.04	**NA**	lb/ton Coke burn
SO_2 LB/1,000 lb COKE BURN	1.03	1.01	1.02	**9.80**	lb/1,000 lb Coke
FCC STACK SO_2 (lb/Hr) (ppm_{dv})	13	13	13	**793.65**	LB/HR
SO_2 CORRECTED 0% O_2	41	40	40	**100**	PPM
FCC FLUE GAS CO (ppm_{dv})	33	36	34	**500**	PPM
Stack Oxygen %	1.25	1.29	1.27	**NA**	%
NO_X CORRECTED 0% O_2 (ppm_{dv})	55	56	55	**90.0**	PPM

Appendix B

Quantitation and Laboratory Reports

FTIR Monitoring Log

St. Paul Park Refining Co. LLC

St. Paul Park, MN
Pace Project No. 12-15-1426

Appendix B

FTIR Spectral Log - Group 1 of 1
FCC Regenerator Stack
Test 1

Final log Constituents 1 - 6 of 6

File Name	Date/Time	Hydrogen Cyanide PPMv, Wet	Water Vapor %v/v, Wet	Carbon Monoxide PPMv, Dry	Carbon Dioxide %v/v, Dry	Oxides of Nitrogen PPMv, Dry	Sulfur Dioxide PPMv, Dry	Calibration Notes
MKS3__0001BKG.LAB	5/27/2015 9:17	0	0	0	0	0	0	
MKS3__0002.LAB	5/27/2015 9:22	0	0	0.00738	0	0	0	
MKS3__0003.LAB	5/27/2015 9:27	0	0	0.0442	0.000563	0.0175	0.0549	
MKS3__0004.LAB	5/27/2015 9:32	0.0283	0	0.0295	0.00118	0.0727	0	
MKS3__0005.LAB	5/27/2015 9:37	0.0777	0	0	0.00123	0	0	
MKS3__0006.LAB	5/27/2015 9:42	0.0624	0	0	0	0	0	
MKS3__0007.LAB	5/27/2015 9:47	0.0742	0	0.00594	0	0.0250	0	
MKS3__0008.LAB	5/27/2015 9:52	0.00194	0	0.0187	0.000496	0.0122	0	
MKS3__0009.LAB	5/27/2015 9:57	0	0	0.0250	0	0.0355	0	
MKS3__0010.LAB	5/27/2015 10:02	0	0	0	0.000354	0.0593	0	
MKS3__0011BKG.LAB	5/27/2015 10:13	0	0	0	0	0	0	
MKS3__0012.LAB	5/27/2015 10:19	0	0.00184	0.0439	0	0.0345	0.0208	
MKS3__0013.LAB	5/27/2015 10:24	0	0.000196	0.0623	0	0.0232	0.0355	
MKS3__0014.LAB	5/27/2015 10:29	6.55	1.21	6.81	3.41	11.4	6.62	
MKS3__0015.LAB	5/27/2015 10:34	30.6	4.86	33.5	19.2	64.5	35.4	
MKS3__0016.LAB	5/27/2015 10:39	31.9	5.55	35.9	19.1	64.6	36.0	
MKS3__0017.LAB	5/27/2015 10:46	35.1	6.91	42.6	19.6	44.9	44.3	
MKS3__0018.LAB	5/27/2015 10:51	34.5	7.54	40.4	19.6	46.0	42.5	
MKS3__0019.LAB	5/27/2015 10:56	29.7	7.97	32.2	16.9	51.0	34.2	
MKS3__0020.LAB	5/27/2015 11:01	18.7	7.83	20.9	9.70	29.9	19.4	
MKS3__0021.LAB	5/27/2015 11:06	33.2	7.53	37.7	18.9	50.0	38.2	
MKS3__0022.LAB	5/27/2015 11:11	33.2	8.06	40.2	19.0	45.5	39.4	
MKS3__0023.LAB	5/27/2015 11:16	27.1	8.72	31.7	14.2	35.9	32.0	
MKS3__0024.LAB	5/27/2015 11:21	28.5	14.0	36.7	18.6	56.8	30.8	
MKS3__0025.LAB	5/27/2015 11:23	29.5	9.26	34.9	18.6	59.5	31.1	
MKS3__0026.LAB	5/27/2015 11:24	30.2	9.04	35.7	18.7	57.5	33.6	
MKS3__0027.LAB	5/27/2015 11:25	31.0	8.88	36.3	18.8	54.8	36.3	
MKS3__0028.LAB	5/27/2015 11:26	32.3	8.86	39.9	19.0	47.4	40.0	
MKS3__0029.LAB	5/27/2015 11:27	33.0	8.86	39.6	19.0	45.4	40.7	
MKS3__0030.LAB	5/27/2015 11:28	33.5	8.90	39.8	19.0	47.2	41.4	
MKS3__0031.LAB	5/27/2015 11:29	33.7	8.89	41.9	19.0	45.8	42.8	
MKS3__0032.LAB	5/27/2015 11:30	34.1	8.99	40.2	19.1	44.6	43.2	
MKS3__0033.LAB	5/27/2015 11:31	34.2	9.08	39.7	19.0	45.9	42.9	

File Name	Date/Time	Hydrogen Cyanide PPMv, Wet	Water Vapor %v/v, Wet	Carbon Monoxide PPMv, Dry	Carbon Dioxide %v/v, Dry	Oxides of Nitrogen PPMv, Dry	Sulfur Dioxide PPMv, Dry	Calibration Notes
MKS3__0034.LAB	5/27/2015 11:32	34.0	9.17	41.3	19.1	44.5	42.9	
MKS3__0035.LAB	5/27/2015 11:33	35.4	9.24	43.0	19.1	43.7	43.4	
MKS3__0036.LAB	5/27/2015 11:34	34.7	9.32	44.0	19.2	41.9	44.1	
MKS3__0037.LAB	5/27/2015 11:35	33.6	9.38	39.3	19.1	46.2	42.2	
MKS3__0038.LAB	5/27/2015 11:36	33.0	9.43	39.3	19.1	45.1	42.5	
MKS3__0039.LAB	5/27/2015 11:37	33.1	9.49	44.6	19.1	43.6	43.0	
MKS3__0040.LAB	5/27/2015 11:38	33.3	9.58	43.0	19.1	43.3	41.7	
MKS3__0041.LAB	5/27/2015 11:39	32.8	9.53	38.8	19.0	45.7	40.4	
MKS3__0042.LAB	5/27/2015 11:40	32.5	9.48	38.4	19.0	45.4	40.8	
MKS3__0043.LAB	5/27/2015 11:41	32.4	9.45	36.8	19.0	47.1	40.0	
MKS3__0044.LAB	5/27/2015 11:42	31.1	9.40	35.2	18.9	48.2	39.0	
MKS3__0045.LAB	5/27/2015 11:44	31.5	9.38	35.8	19.0	48.7	39.7	
MKS3__0046.LAB	5/27/2015 11:45	31.6	9.34	35.3	19.1	47.2	39.8	
MKS3__0047.LAB	5/27/2015 11:46	31.6	9.32	35.9	19.0	46.7	39.7	
MKS3__0048.LAB	5/27/2015 11:47	31.6	9.33	36.7	19.0	48.4	39.7	
MKS3__0049.LAB	5/27/2015 11:48	31.5	9.37	36.4	19.0	49.5	38.7	
MKS3__0050.LAB	5/27/2015 11:49	30.8	9.50	34.8	18.9	50.7	37.3	
MKS3__0051.LAB	5/27/2015 11:50	30.3	9.54	32.1	18.9	53.9	35.0	
MKS3__0052.LAB	5/27/2015 11:51	29.1	9.80	30.5	18.8	56.2	33.6	
MKS3__0053.LAB	5/27/2015 11:52	29.5	9.73	32.1	18.8	54.0	34.5	
MKS3__0054.LAB	5/27/2015 11:53	30.2	9.64	32.6	18.9	52.1	35.9	
MKS3__0055.LAB	5/27/2015 11:54	30.2	9.49	32.4	18.8	55.1	35.0	
MKS3__0056.LAB	5/27/2015 11:55	30.6	9.47	33.5	18.8	52.1	37.2	
MKS3__0057.LAB	5/27/2015 11:56	32.6	9.45	44.7	19.0	44.0	41.7	
MKS3__0058.LAB	5/27/2015 11:57	37.6	9.40	90.3	19.3	30.8	48.3	
MKS3__0059.LAB	5/27/2015 11:58	37.7	9.36	66.2	19.3	33.6	46.0	
MKS3__0060.LAB	5/27/2015 11:59	37.8	9.31	85.8	19.3	30.9	47.4	
MKS3__0061.LAB	5/27/2015 12:00	39.1	9.23	105	19.3	27.6	48.5	
MKS3__0062.LAB	5/27/2015 12:01	38.6	9.24	80.2	19.3	30.5	46.9	
MKS3__0063.LAB	5/27/2015 12:02	36.6	9.30	53.5	19.2	36.2	43.8	
MKS3__0064.LAB	5/27/2015 12:03	35.4	9.31	51.2	19.1	37.0	43.0	
MKS3__0065.LAB	5/27/2015 12:04	34.8	9.30	44.3	19.1	38.2	42.3	
MKS3__0066.LAB	5/27/2015 12:05	33.8	9.34	39.7	19.0	42.8	40.3	

St. Paul Park Refining Co. LLC

St. Paul Park, MN
Pace Project No. 12-15-1426

Appendix B

FTIR Spectral Log - Group 1 of 1
FCC Regenerator Stack
Test 1

Final log Constituents 1 - 6 of 6

File Name	Date/Time	Hydrogen Cyanide PPMv, Wet	Water Vapor %v/v, Wet	Carbon Monoxide PPMv, Dry	Carbon Dioxide %v/v, Dry	Oxides of Nitrogen PPMv, Dry	Sulfur Dioxide PPMv, Dry	Calibration Notes
MKS3__0067.LAB	5/27/2015 12:06	33.3	9.34	39.4	18.9	45.5	39.8	
MKS3__0068.LAB	5/27/2015 12:07	32.5	9.35	38.5	18.7	43.3	39.3	
MKS3__0069.LAB	5/27/2015 12:08	32.1	9.38	38.7	18.4	44.0	37.5	
MKS3__0070.LAB	5/27/2015 12:09	24.9	9.36	24.7	15.9	32.1	26.4	
MKS3__0071.LAB	5/27/2015 12:10	5.80	9.34	2.06	10.4	1.99	2.89	
MKS3__0072.LAB	5/27/2015 12:11	2.55	9.36	0.619	10.1	0	0.749	
MKS3__0073.LAB	5/27/2015 12:12	1.72	9.34	0.482	10.0	0	0.274	
MKS3__0074.LAB	5/27/2015 12:13	1.38	9.28	0.547	10.0	0	0.0389	
MKS3__0075.LAB	5/27/2015 12:14	1.01	9.12	0.488	**10.0**	0	0	CO2:10.0%
MKS3__0076.LAB	5/27/2015 12:15	0.752	8.96	6.64	8.72	5.61	4.09	
MKS3__0077.LAB	5/27/2015 12:16	0.662	8.70	46.5	0.989	44.5	40.5	
MKS3__0078.LAB	5/27/2015 12:17	0.384	8.49	51.5	0.0553	49.2	47.7	
MKS3__0079.LAB	5/27/2015 12:18	0.367	8.47	51.6	0.0428	49.3	48.0	
MKS3__0080.LAB	5/27/2015 12:19	0.489	8.89	51.7	0.0327	49.4	47.7	CO/NO/SO2
MKS3__0081.LAB	5/27/2015 12:20	0.323	8.20	**51.5**	0.0267	**49.4**	**48.3**	50.9/49.8/48.2
MKS3__0082.LAB	5/27/2015 12:21	20.2	8.05	38.2	12.7	48.5	36.4	
MKS3__0083.LAB	5/27/2015 12:22	31.3	8.55	38.8	18.8	59.0	36.2	
MKS3__0084.LAB	5/27/2015 12:23	31.2	8.62	39.6	18.6	62.2	34.1	
MKS3__0085.LAB	5/27/2015 12:24	31.2	8.75	39.6	18.6	61.9	34.0	
MKS3__0086.LAB	5/27/2015 12:25	31.5	8.83	39.4	18.7	60.5	34.6	
MKS3__0087.LAB	5/27/2015 12:26	32.3	8.86	41.1	18.7	56.6	36.5	
MKS3__0088.LAB	5/27/2015 12:27	32.6	8.90	39.7	18.6	57.2	36.2	
MKS3__0089.LAB	5/27/2015 12:28	32.4	8.92	39.9	18.7	56.8	36.8	
MKS3__0090.LAB	5/27/2015 12:29	33.9	8.93	41.3	18.8	53.7	38.4	
MKS3__0091.LAB	5/27/2015 12:30	33.9	8.92	40.4	18.8	55.7	37.0	
MKS3__0092.LAB	5/27/2015 12:31	33.2	8.87	39.5	18.7	56.9	35.8	
MKS3__0093.LAB	5/27/2015 12:32	32.5	8.81	39.8	18.6	59.7	34.8	
MKS3__0094.LAB	5/27/2015 12:33	32.7	8.75	39.9	18.6	58.2	35.9	
MKS3__0095.LAB	5/27/2015 12:34	32.7	8.73	38.0	18.7	56.3	36.9	
MKS3__0096.LAB	5/27/2015 12:35	33.8	8.64	38.4	18.7	52.7	38.6	
MKS3__0097.LAB	5/27/2015 12:36	33.5	8.48	38.3	18.7	54.3	36.8	
MKS3__0098.LAB	5/27/2015 12:37	33.3	8.47	37.4	18.7	56.0	35.5	
MKS3__0099.LAB	5/27/2015 12:38	33.3	8.43	37.6	18.8	57.8	35.8	

File Name	Date/Time	Hydrogen Cyanide PPMv, Wet	Water Vapor %v/v, Wet	Carbon Monoxide PPMv, Dry	Carbon Dioxide %v/v, Dry	Oxides of Nitrogen PPMv, Dry	Sulfur Dioxide PPMv, Dry	Calibration Notes
MKS3__0100.LAB	5/27/2015 12:39	33.5	8.30	37.1	18.7	55.3	36.7	
MKS3__0101.LAB	5/27/2015 12:40	34.3	8.19	40.0	18.8	51.3	38.7	
MKS3__0102.LAB	5/27/2015 12:41	37.1	8.12	46.6	19.0	44.0	42.2	
MKS3__0103.LAB	5/27/2015 12:42	38.4	8.38	54.7	19.1	38.7	44.4	
MKS3__0104.LAB	5/27/2015 12:43	38.8	8.35	57.3	19.2	39.6	44.7	
MKS3__0105.LAB	5/27/2015 12:44	39.1	8.27	63.2	19.2	36.1	45.8	
MKS3__0106.LAB	5/27/2015 12:45	39.0	8.16	51.2	19.2	37.8	44.4	
MKS3__0107.LAB	5/27/2015 12:46	37.0	8.06	43.8	19.1	41.3	41.9	
MKS3__0108.LAB	5/27/2015 12:47	35.9	7.99	41.0	19.1	42.2	41.5	
MKS3__0109.LAB	5/27/2015 12:48	36.5	7.93	44.8	19.0	41.8	41.7	
MKS3__0110.LAB	5/27/2015 12:49	35.7	7.91	40.9	19.0	45.4	40.2	
MKS3__0111.LAB	5/27/2015 12:50	34.5	7.86	36.0	18.9	48.9	38.6	
MKS3__0112.LAB	5/27/2015 12:51	34.0	8.01	35.8	18.9	50.9	37.4	

System Identification:	MKS - Instrument MKS3
Test Start Date:	May 27, 2015
Test End Date:	May 27, 2015

No. of Target Constituents:	6
No. of FTIR Log Entries:	112

First Log Entry:	MKS3__0001BKG.LAB	5/27/2015 9:17
Last Log Entry:	MKS3__0112.LAB	5/27/2015 12:51

The preceding log of collected FTIR spectra, as identified above, is a true and accurate record of instrument results contingent to the standardized instrument software and operator configured method maps. Instrument baseline 'noise' recorded as negative values have been normalized to zero. No other adjustment to the raw instrument/software generated results have been made. I certify the log is a true record of the test results subject to the precision and accuracy of the method, matrix and instrumentation.

Brett D. Erickson

Appendix C

Calculation Equations and Report Nomenclature

Calculation Equations

Gas Concentration Calculations

Weight/Volume Concentration

$$C_{mg/dscm} = \frac{m}{V_{std}}$$

Volume/Volume Concentration

$$C_{PPM} = \frac{C_{mg/cm} \; x \; 24.055}{MW}$$

Emission Rate

$$E_{Gas} = \left(6.242 \; x \; 10^{-8}\right) x \; 60 \; x \; C_{mg/dscm} \; x \; DSCFM$$

Where:

$C_{mg/cm}$	=	Compound Concentration, mg/cubic meter.
C_{ppm}	=	Compound Concentration, PPM v/v.
DSCFM	=	Volumetric Airflow, dry standard cubic feet per minute.
E_{Gas}	=	Compound Emission Rate, LB/HR.
m	=	Mass of Compound Collected, µg.
MW	=	Molecular Weight of Compound.
V_{std}	=	Standard Volume of Air Sample, liters.
(6.242×10^{-8})	=	Conversion From mg/dscm To LB/CF.
60	=	Conversion From Minutes to Hours.

Moisture Correction Calculations

Wet to Dry Concentration Correction

$$C_{dry} = \frac{C_{wet}}{\left(1 - \frac{MC_{source}}{100}\right)}$$

Dry to Wet Concentration Correction

$$C_{wet} = C_{dry} \times \left(1 - \frac{MC_{source}}{100}\right)$$

Wet Analytical Basis to Wet Stack Basis

$$C_{wet-s} = \frac{C_{wet-a}}{\left(1 - \frac{MC_{analyses}}{100}\right)} \times \left(1 - \frac{MC_{source}}{100}\right)$$

Note: Changes in temperature and pressure from the source to analysis affect the moisture capacity of the gas sample. 100% rH at laboratory conditions, or 2.5% v/v, is assumed for the analysis moisture content. If another value is used, it will be noted in the Results Summary. Care must be taken to ensure that analytes of interest are not soluble in the resulting condensate.

Where:

C_{dry}	=	Compound Concentration,dry basis, not unit specfic.
C_{wet}	=	Compound Concentration,wet basis, not unit specfic.
C_{wet-a}	=	Compound Concentration,wet basis, at analysis.
C_{wet-s}	=	Compound Concentration,wet basis, in source gas.
$MC_{analysis}$	=	Moisture content of gas at analytical conditions.
MC_{source}	=	Moisture content of gas at source conditions.

EPA Method 320 Quantitative Analyses

Absorbance

$$A = \log_{10}(1/T) = -\log_{10}T$$

Where:

A	=	Absorbance of compound.
$\log_{10}$	=	Logarithm to the base 10.
$(1/T)$	=	Reciprocal of the transmittance.

Beer's Law

$$A_v = a_i b c_i$$

Where:

A_v	=	Absorbance of the I^{th} component at the given frequency, *v*.
a_i	=	Absorption coefficient of the I^{th} component at the frequency, *v*.
b	=	FTIR calculated cell path length in meters.
c_i	=	Concentration of the I^{th} compound in the sample at frequency, *v*.

FTIR Spectral Analysis

$$PPMv = \left((SF \bullet Sample°K \bullet (LibraryPPM * m / Library°K))/CellPathLength,m\right)$$

Where:

$PPMv$	=	Compound Concentration, parts per million by volume.
SF	=	Compound subtracted scale factor (Spectral difference versus library reference standard).
$Sample°K$	=	Temperature of sample gas in degrees Kelvin.
$LibraryPPM * m$	=	Reference library standard concentration in parts per million - meters.
$Library°K$	=	Temperature of reference standard gas in degrees Kelvin.
$CellPathLength,m$	=	FTIR calculated cell path length in meters.

Report Nomenclature

Abbreviations, Symbols, and Nomenclature

"Hg	Inches of Mercury (pressure)
"WC	Inches Water Column (pressure)
°C	Degrees Centigrade or Celsius
°F	Degrees Fahrenheit
°K	Degrees Kelvin (absolute)
°R	Degrees Rankin (absolute)
% v/v	Percent by volume
% w/w	Percent by weight
ACFM	Actual Cubic Feet per Minute
AP-42	Compilation of Air Pollutant Emission Factors, Volume I, Stationary Point and Area Sources.
BACT	Best Available Control Technology
BH	Baghouse
BHP	Brake Horsepower
BTU	British Thermal Unit
c	Centimeter
c^3	Cubic Centimeter
cc	Cubic Centimeter
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CE	Control Equipment (in Reg. ID Nos.)
CE	Control Efficiency
CEM	Continuous Emissions Monitor
CEMS	Continuous Emissions Monitoring System
CF	Cubic Feet
CFR	Code of Federal Regulations
C_1	Carbon (as carbon)
CH_4	Methane
C_3H_8	Propane
cm	Cubic Meter
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DGS	Distiller's Grains with Solubles
DDGS	Dry Distiller's Grains with Solubles
DRE	Destruction/Reduction Efficiency
DSCF	Dry Standard Cubic Feet
DSCFM	Dry Standard Cubic Feet per Minute
dscm	Dry Standard Cubic Meter
dscmm	Dry Standard Cubic Meter per Minute
dsl	Dry Standard Liter
EPA	Environmental Protection Agency
EP	Emission Point
ESP	Electrostatic Precipitator
EU	Emission Unit
FID	Flame Ionization Detector
FGR	Flue Gas Recirculation
FPD	Flame Photometric Detector
FPM	Feet Per Minute
FPS	Feet Per Second
FR	Federal Register
FT or ft	Foot or Feet
FT^3	Cubic Feet
FTIR	Fourier Transform Infrared
g	Gram
GC	Gas Chromatograph(y)
GPD	Gallons Per Day
GPH	Gallons Per Hour
GR	Grains
H_2O	Water
H_2S	Hydrogen Sulfide
HAP	Hazardous Air Pollutant
HAPs	Hazardous Air Pollutants
Hg	Mercury
HP	Horsepower
HR	Hour
In.	Inch or Inches
KLB	Thousand Pounds
kW	Kilowatt
kWH	Kilowatt Hour
l	liter
LB	Pound or Pounds
LDAR	Leak Detection and Repair
m	Meter
m^3	Cubic Meter
MACT	Maximum Achievable Control Technology
MC	Moisture Content
µg	Microgram
µl	Microliter
µm	Micrometer (micron)
mg	Milligram
MGAL	Thousand Gallons
Min.	Minute or Minutes
ml	Milliliter
mm	Millimeter
MMBTU	Million British Thermal Units
MMSCF	Million Standard Cubic Feet
MS	Mass Spectrometry
MSDS	Material Safety Data Sheet
mW	Megawatt
MW	Molecular Weight
N_2	Nitrogen
NA	Not Applicable
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides (quantified as NO_2)
NSPS	New Source Performance Standard
O_2	Oxygen
PEMS	Parametric (or Predictive) Emissions Monitoring System
PID	Photo Ionization Detector
PM	Particulate Matter

PM_{10}	Particulate Matter with an aerodynamic diameter equal to or less than 10 microns
PM-10	PM_{10}
$PM_{2.5}$	Particulate Matter with and aerodynamic diameter equal to or less than 2.5 microns
PM-2.5	$PM_{2.5}$
PPB	Parts Per Billion (see variation below)
PPM	Parts Per Million
PPMv	Part Per Million by volume
PPMv-dry	Parts Per Million by volume, dry basis
PPMv-wet	Parts Per Million by volume, wet basis
PPMw	Parts Per Million by Weight (mg/l)
PSIA	Pounds per Square Inch, Absolute
PSIG	Pounds per Square Inch, Gauge
PTE	Permanent Total Enclosure
RA	Relative Accuracy
RATA	Relative Accuracy Test Audit
rH	Relative Humidity
RTO	Regenerative Thermal Oxidizer or Recuperative Thermal Oxidizer
SCF	Standard Cubic Feet
SCFM	Standard Cubic Feet per Minute
scm	Standard Cubic Meter
scmm	Standard Cubic Meter per Minute
Scr.	Scrubber
SIC	Standard Industrial Classification
SO_2	Sulfur Dioxide
SO_x	Sulfur Oxides
Sq. Ft.	Square Feet
TCD	Thermal Conductivity Detector
TO	Thermal Oxidizer
TPD	Tons Per Day
TPH	Tons Per Hour
TPY	Tons per year
TRS	Total Reduced Sulfur
TSP	Total Suspended Particulate Matter
TTE	Temporary Total Enclosure
USEPA	United States Environmental Protection Agency
VHAP	Volatile Hazardous Air Pollutant
VOC	Volatile Organic Compound
VOCs	Volatile Organic Compounds
WC	Water Column
WDGS	Wet Distiller's Grains with Solubles

State Environmental Agency Acronyms

ADEM	Alabama Department of Environmental Management
ADEC	Alaska Department of Environmental Conservation
ADEQ	Arizona Department of Environmental Quality
ADEQ	Arkansas Department of Environmental Quality
CARB	California Air Resources Board
CDPHE	Colorado Department of Public Health & Environment
CDEP	Connecticut Department of Environmental Protection
DNREC	Delaware Natural Resources & Environmental Control
FDEP	Florida Department of Environmental Protection
GEPD	Georgia Environmental Protection Division
IDEQ	Idaho Department of Environmental Quality
IEPA	Illinois Environmental Protection Agency
IDNR	Iowa Department of Natural Resources
KDHE	Kansas Department of Health & Environment
KDEP	Kentucky Department for Environmental Protection
LDEQ	Louisiana Department of Environmental Quality
MDEP	Maine Department of Environmental Protection
MDE	Maryland Department of the Environment
MDEP	Massachusetts Department of Environmental Protection
MDEQ	Michigan Department of Environmental Quality
MPCA	Minnesota Pollution Control Agency
MDEQ	Mississippi Department of Environmental Quality
MDNR	Missouri Department of Natural Resources
MDEQ	Montana Department of Environmental Quality
NDEQ	Nebraska Department of Environmental Quality
NDEP	Nevada Division of Environmental Protection
NHDES	New Hampshire Department of Environmental Services
NJDEP	New Jersey Department of Environmental Protection
NMED	New Mexico Environment Department
NYSDEC	New York State Department of Environmental Conservation
NCDENR	North Carolina Department of Environment & Natural Resources
NDDH	North Dakota Department of Health
OEPA	Ohio Environmental Protection Agency
ODEQ	Oklahoma Department of Environmental Quality
ODEQ	Oregon Department of Environmental Quality
PDEP	Pennsylvania Department of Environmental Protection
RIDEM	Rhode Island Department of Environmental Management
SCDHEC	South Carolina Department of Health & Environmental Control
SDDENR	South Dakota Department of Environment & Natural Resources
TDEC	Tennessee Department of Environment & Conservation
TCEQ	Texas Commission on Environmental Quality
UDEQ	Utah Department of Environmental Quality
VANR	Vermont Agency of Natural Resources
VDEQ	Virginia Department of Environmental Quality
WSDNR	Washington State Department of Natural Resources
WVDEP	West Virginia Division of Environmental Protection
WDNR	Wisconsin Department of Natural Resources

Appendix D

Quality Assurance Information

Calibration Gas Certifications

PRAXAIR

Praxair Distribution, Inc.
6055 Brent Drive
Toledo, OH 43611
Tel: (419) 729-7732 Fax:(419) 729-2411
PGVP ID: F12014

DocNumber: 000005066

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information:

PRAXAIR WHSE MINNEAPOLIS M
2801 E HENNEPIN 2455 ROSEGA
MINNEAPOLIS MN 554130

Praxair Order Number: 28105969
Customer P. O. Number: 05046324
Customer Reference Number:

Fill Date: 7/23/2014
Part Number: NI CD10O28E-AS
Lot Number: 0723WE14
Cylinder Style & Outlet: AS CGA 590
Cylinder Pressure & Volume: 2000 psig 140 cu. ft.

Certified Concentration:

Expiration Date:	7/29/2022	NIST Traceable
Cylinder Number:	EB0002914	Analytical Uncertainty:
11.0 %	OXYGEN	± 0.2 %
10.0 %	CARBON DIOXIDE	± 0.4 %
Balance	NITROGEN	

Certifcation Information: *Certification Date:* 7/29/2014 *Term:* 96 Months *Expiration Date:* 7/29/2022

This cylinder was certified according to the 2012 EPA Traceability Protocol, Document #EPA-600/R-12/531, using Procedure G1. Do Not Use this Standard if Pressure is less than 100 PSIG.

Analytical Data: *(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)*

1. Component: OXYGEN

Requested Concentration: 11.0 %
Certified Concentration: 11.0 %
Instrument Used: Servomex 575
Analytical Method: Paramagnetic
Last Multipoint Calibration: 6/24/2014

First Analysis Data:						Date: 7/29/2014
Z: 0	R: 22.62	C: 10.98	Conc: 10.98			
R: 22.62	Z: 0	C: 10.98	Conc: 10.98			
Z: 0	C: 10.98	R: 22.62	Conc: 10.98			
UOM: %		Mean Test Assay: 10.98 %				

Reference Standard Type: GMIS
Ref. Std. Cylinder # : CC200088
Ref. Std. Conc: 22.62%
Ref. Std. Traceable to SRM # : 2659a
SRM Sample # : 71-D-04
SRM Cylinder # : CAL015785

Second Analysis Data:						Date:
Z: 0	R: 0	C: 0	Conc: 0			
R: 0	Z: 0	C: 0	Conc: 0			
Z: 0	C: 0	R: 0	Conc: 0			
UOM: %		Mean Test Assay: 0 %				

2. Component: CARBON DIOXIDE

Requested Concentration: 10.0 %
Certified Concentration: 10.0 %
Instrument Used: MKS 2031
Analytical Method: FOURIER-TRANSFORM INFRAR
Last Multipoint Calibration: 7/8/2014

First Analysis Data:						Date: 7/29/2014
Z: 0	R: 19.87	C: 10.03	Conc: 10.03			
R: 19.87	Z: 0	C: 10.03	Conc: 10.03			
Z: 0	C: 10.03	R: 19.87	Conc: 10.03			
UOM: %		Mean Test Assay: 10.03 %				

Reference Standard Type: GMIS
Ref. Std. Cylinder # : EB0023062
Ref. Std. Conc: 19.87
Ref. Std. Traceable to SRM # : 2745
SRM Sample # : 9-C-03
SRM Cylinder # : CAL016000

Second Analysis Data:						Date:
Z: 0	R: 0	C: 0	Conc: 0			
R: 0	Z: 0	C: 0	Conc: 0			
Z: 0	C: 0	R: 0	Conc: 0			
UOM: %		Mean Test Assay: 0 %				

Analyzed by: Mike Monnette 12/08

Certified by: Josh Jones

PRAXAIR

Praxair Distribution, Inc,
6055 Brent Drive
Toledo, OH 43611
Tel: (419) 729-7732 Fax:(419) 729-2411
PGVP ID: F12014

DocNumber: 000004083

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information:

PRAXAIR WHSE MINNEAPOLIS M
2801 E HENNEPIN 2455 ROSEGA
MINNEAPOLIS MN 554130

Praxair Order Number: 27252246
Customer P. O. Number: 04934474
Customer Reference Number:

Fill Date: 5/2/2014
Part Number: NI CO50MNS3ZEAS
Lot Number: 0502HK14
Cylinder Style & Outlet: AS CGA 660
Cylinder Pressure & Volume: 2000 psig 140 cu. ft.

Certified Concentration:

Expiration Date:	5/16/2022	NIST Traceable
Cylinder Number:	EB0027344	Analytical Uncertainty:
49.8 ppm	NITRIC OXIDE	± 0.7 %
48.2 ppm	SULFUR DIOXIDE	± 1 %
50.9 ppm	CARBON MONOXIDE	± 0.4 %
Balance	NITROGEN	

Certifcation Information: *Certification Date:* 5/16/2014 *Term:* 96 Months *Expiration Date:* 5/16/2022

This cylinder was certified according to the 2012 EPA Traceability Protocol, Document #EPA-600/R-12/531, using Procedure G1.
Do Not Use this Standard if Pressure is less than 100 PSIG.

NO2= 0.3 ppm

Analytical Data: *(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)*

1. Component: NITRIC OXIDE

Requested Concentration: 50 ppm
Certified Concentration: 49.8 ppm
Instrument Used: Rosemount 951A
Analytical Method: Chemiluminescent
Last Multipoint Calibration: 4/19/2014

First Analysis Data:						Date:	5/9/2014
Z: 0	R: 49.9	C: 49.8	Conc: 49.82				
R: 49.9	Z: 0	C: 49.8	Conc: 49.82				
Z: 0	C: 49.8	R: 49.9	Conc: 49.82				
UOM: PPM			Mean Test Assay:	49.82 PPM			

Reference Standard Type: GMIS
Ref. Std. Cylinder # : CC211737
Ref. Std. Conc: 49.92 ppm
Ref. Std. Traceable to SRM # : 1683b
SRM Sample # : 45-V-25
SRM Cylinder # : CAL018124

Second Analysis Data:						Date:	5/16/2014
Z: 0	R: 50	C: 49.9	Conc: 49.82				
R: 50	Z: 0	C: 49.9	Conc: 49.82				
Z: 0	C: 49.9	R: 50	Conc: 49.82				
UOM: PPM			Mean Test Assay:	49.82 PPM			

2. Component: SULFUR DIOXIDE

Requested Concentration: 50 ppm
Certified Concentration: 48.2 ppm
Instrument Used: AMETEK 921
Analytical Method: NDUV
Last Multipoint Calibration: 4/22/2014

First Analysis Data:						Date:	5/9/2014
Z: 0	R: 51.3	C: 48.2	Conc: 48.209				
R: 51.3	Z: 0	C: 48.2	Conc: 48.209				
Z: 0	C: 48.2	R: 51.3	Conc: 48.209				
UOM: PPM			Mean Test Assay:	48.209 PPM			

Reference Standard Type: GMIS
Ref. Std. Cylinder # : CC283492
Ref. Std. Conc: 51.31 ppm
Ref. Std. Traceable to SRM # : 1693a
SRM Sample # : 96-K-078
SRM Cylinder # : CAL015221

Second Analysis Data:						Date:	5/16/2014
Z: 0	R: 51.4	C: 48.3	Conc: 48.215				
R: 51.4	Z: 0	C: 48.3	Conc: 48.215				
Z: 0	C: 48.3	R: 51.4	Conc: 48.215				
UOM: PPM			Mean Test Assay:	48.215 PPM			

PRAXAIR

Praxair Distribution, Inc,
6055 Brent Drive
Toledo, OH 43611
Tel: (419) 729-7732 Fax:(419) 729-2411
PGVP ID: F12014

DocNumber: 000004083

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

3. Component: CARBON MONOXIDE

Requested Concentration:	50 ppm
Certified Concentration:	50.9 ppm
Instrument Used:	Horiba VIA 510
Analytical Method:	NDIR
Last Multipoint Calibration:	4/24/2014

First Analysis Data:						**Date:**	5/9/2014
Z:	0	R:	50.3	C:	50.4	Conc:	50.931
R:	50.3	Z:	0	C:	50.4	Conc:	50.931
Z:	0	C:	50.4	R:	50.3	Conc:	50.931
UOM:	PPM			Mean Test Assay:			50.931 PPM

Analyzed by: Edward E Zuca

Reference Standard Type:	GMIS
Ref. Std. Cylinder # :	CC309017
Ref. Std. Conc:	50.83 PPM
Ref. Std. Traceable to SRM # :	1678c
SRM Sample # :	4-K-13
SRM Cylinder # :	CAL016816

Second Analysis Data:						**Date:**	
Z:	0	R:	0	C:	0	Conc:	0
R:	0	Z:	0	C:	0	Conc:	0
Z:	0	C:	0	R:	0	Conc:	0
UOM:	PPM			Mean Test Assay:			0 PPM

Certified by: Josh Jones

FTIR Calibration Summary

St. Paul Park Refining Co. LLC

St. Paul Park, MN
Pace Project No. 12-15-1426

Appendix D

FTIR Calibration Summary
FCC Regenerator Stack
Test 1

FTIR Cell Path Length: 5.11m

Calibration Acceptance Criterion: ± 5.0%

Calibration Trial 1		**Carbon Monoxide**	**Target PPMv: 50.9**	
Spectra File Name	Date and Time	PPMv	Deviation	Status
MKS3__0077.LAB	5/27/15 12:16	46.45		
MKS3__0078.LAB	5/27/15 12:17	51.49		
MKS3__0079.LAB	5/27/15 12:18	51.59		
MKS3__0080.LAB	5/27/15 12:19	51.69		
MKS3__0081.LAB	5/27/15 12:20	**51.46**	**1.1%**	**Pass**

Calibration Trial 2		**Nitric Oxide**	**Target PPMv: 49.8**	
Spectra File Name	Date and Time	PPMv	Deviation	Status
MKS3__0077.LAB	5/27/15 12:16	44.50		
MKS3__0078.LAB	5/27/15 12:17	49.22		
MKS3__0079.LAB	5/27/15 12:18	49.31		
MKS3__0080.LAB	5/27/15 12:19	49.43		
MKS3__0081.LAB	5/27/15 12:20	**49.42**	**-0.8%**	**Pass**

Calibration Trial 3		**Sulfur Dioxide**	**Target PPMv: 48.2**	
Spectra File Name	Date and Time	PPMv	Deviation	Status
MKS3__0077.LAB	5/27/15 12:16	40.50		
MKS3__0078.LAB	5/27/15 12:17	47.67		
MKS3__0079.LAB	5/27/15 12:18	48.03		
MKS3__0080.LAB	5/27/15 12:19	47.66		
MKS3__0081.LAB	5/27/15 12:20	**48.34**	**0.3%**	**Pass**

Calibration Trial 4		**Carbon Dioxide**	**Target %v/v: 10**	
Spectra File Name	Date and Time	%v/v	Deviation	Status
MKS3__0071.LAB	5/27/15 12:10	10.39		
MKS3__0072.LAB	5/27/15 12:11	10.07		
MKS3__0073.LAB	5/27/15 12:12	10.05		
MKS3__0074.LAB	5/27/15 12:13	10.03		
MKS3__0075.LAB	5/27/15 12:14	**10.04**	**0.4%**	**Pass**

Calibration Deviation is based on the last of 3 stable cylinder gas readings.

Calibration Gas List

Constituent	Gas Concentration	Certificate No.
Carbon Monoxide	50.9 PPMv	EB0027344
Nitric Oxide	49.8 PPMv	EB0027344
Sulfur Dioxide	48.2 PPMv	EB0027344
Carbon Dioxide	10 %v/v	EB0002914